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(54) FIVE-GRADE MOTOR OIL FOR INTERNAL COMBUSTION ENGINES

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The following corrections were allowed under Section 76 on 22 March 1976

Page 1, line 2, *delete* CORPORATION *insert* COMPANY

THE PATENT OFFICE
19 April 1976

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combustion engines despite extreme climatic conditions.

Normally lubricating oils must provide minimal wear in an engine under operating temperatures at the cylinder walls in the combustion zone ranging from well below 0°F. on a winter morning to well above 400°F. To perform this function satisfactorily the oil must have thermal stability, shear stability, and a resistance to breaking down into harmful deposits which show up as "varnish" within the engine. Another important criterion for motor oil performance is that it have low consumption in an engine, particularly because environmental pollution caused by automobile emissions is of concern.

A market has been developed for multi-grade motor oils which besides having all of the characteristics desired in a superior motor oil should provide adequate lubrication throughout the year regardless of climatic conditions or severity of usage.

It is therefor an object of this invention to provide a base oil for a motor oil formulation which comprises a unique blend of several refinery lubricating oil stocks in certain specific proportions which when used in conjunction with well known multi-functional dispersant-detergent additives, viscosity index improvers, and pour point depressants will be consumed at very low levels in the operation associated with the 5W oils. No known blend of refined petroleum-base has previously been described which will meet the specifications required for a multi-grade 5W—40 motor oil having both satisfactory consumption properties and low-temperature cranking properties. It is therefore a further object of this invention to provide a base oil blend for a SAE 5W—40 oil which satisfies both of the above criteria.

The instant invention provides a finished 5W—40 motor oil wherein no more than 12 volume percent of the oil boils below 725°F., has a minimum 300°F. viscosity of 6.5 centistokes, a minimum 210°F. viscosity of 14.7 centistokes, a maximum 0°F. viscosity of 12 poises (cold crank simulator viscosity) and a maximum consumption rate in the engine of about 5.8 quarts/64 hours of oil as defined by the Sequence IIIC test (SAE-General Motors-6041).

In accordance with this invention, the base oil for the multi-grade motor oil consists of a specific blend of two selected solvent extracted neutral mineral oils, one having a viscosity of about 140 SSU at 100°F., or a viscosity of 100 SSU at 100°F., having a boiling point in the range of 720 to 835°F, a viscosity of from 3.9 to 4.2 centistokes at 710°F. and a maximum viscosity of 6.15 poises at 0°F., and the other having a visco-

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(54) FIVE-GRADE MOTOR OIL FOR INTERNAL COMBUSTION ENGINES

(71) We, THE STANDARD OIL CORPORATION, a body corporate organised under the laws of the State of Ohio, United States of America, of Midland Buildings, Cleveland, Ohio 44115, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a motor oil composition for gasoline internal combustion engines. More particularly this invention relates to a blended motor oil base stock that will provide adequate lubrication for internal combustion engines despite extreme climatic conditions.

Normally lubricating oils must provide minimal wear in an engine under operating temperatures at the cylinder walls in the combustion zone ranging from well below 0°F. on a winter morning to well above 400°F. To perform this function satisfactorily the oil must have thermal stability, shear stability, and a resistance to breaking down into harmful deposits which show up as "varnish" within the engine. Another important criterion for motor oil performance is that it have low consumption in an engine, particularly because environmental pollution caused by automobile emissions is of concern.

A market has been developed for multi-grade motor oils which besides having all of the characteristics desired in a superior motor oil should provide adequate lubrication throughout the year regardless of climatic conditions or severity of usage.

It is therefor an object of this invention to provide a base oil for a motor oil formulation which comprises a unique blend of several refinery lubricating oil stocks in certain specific proportions which when used in conjunction with well known multi-functional dispersant-detergent additives, viscosity index improvers, and pour point depressants will be consumed at very low levels in the operation of the engine and will meet the required specifications for a five-grade SAE 5W—40 crankcase oil.

A serious problem generally associated with 5W grade motor oils is oil consumption. It has long been recognized that while 5W oils have excellent low temperature cranking properties they usually are limited to use at ambient temperatures not exceeding 60°F. due to undesirable oil consumption characteristics. At the same time oils of low grade are usually restrictive in relation to low temperature cranking characteristics and are not useful below 0°F., however they do not have the oil consumption problems above 60°F. associated with the 5W oils. No known blend of refined petroleum-base has previously been described which will meet the specifications required for a multi-grade 5W—40 motor oil having both satisfactory consumption properties and low-temperature cranking properties. It is therefore a further object of this invention to provide a base oil blend for a SAE 5W—40 oil which satisfies both of the above criteria.

The instant invention provides a finished 5W—40 motor oil wherein no more than 12 volume percent of the oil boils below 725°F., has a minimum 300°F. viscosity of 6.5 centistokes, a minimum 210°F. viscosity of 14.7 centistokes, a maximum 0°F. viscosity of 12 poises (cold crank simulator viscosity) and a maximum consumption rate in the engine of about 5.8 quarts/64 hours of oil as defined by the Sequence IIIC test (SAE-General Motors-6041).

In accordance with this invention, the base oil for the multi-grade motor oil consists of a specific blend of two selected solvent extracted neutral mineral oils, one having a viscosity of about 140 SSU at 100°F., or a viscosity of 100 SSU at 100°F., having a boiling point in the range of 720 to 835°F, a viscosity of from 3.9 to 4.2 centistokes at 710°F. and a maximum viscosity of 6.15 poises at 0°F., and the other having a visco-

sity of 750 to 800 SSU at 100°F., (hereinafter referred to as SEN 140 or SEN 100 and SEN 750—800, respectively) and at least two separate fractions of a dewaxed and dearomatized catalytically cracked mineral oil stock preferably having an average viscosity of about 85 SSU at 100°F. (herein referred to as a HV1—85 oil).

Solvent extracted neutral oils are well known standard mineral oil refinery stocks. The HV1—85 oil is an end product obtained by fractionating the effluent from a catalytic cracking zone in a tower, running off the bottoms from the tower into a catalyst separation zone where the catalyst fines are settled out, decanting the supernatant phase called cycle oil or decanted oil, and extracting the decanted oil with a solvent for the removal of aromatics. The extract phase containing the aromatic is removed, and the raffinate phase containing the paraffinic stock is led to a dewaxing zone where wax is separated, leaving a dewaxed oil product which is the HV1—85 oil used in the instant invention. A process for obtaining a wax composition from a catalytic cracking stock, leaving a dewaxed oil product, is described in U.S. Patent No. 2,660,553.

The base oil of this invention comprises a carefully balanced mixture of the aforementioned refinery stocks so that a light component and a heavy component are formulated and are combined to fulfill the SAE 5W and the SAE 40 requirements of the multi-grade motor oil. The light component which fulfills the SAE—5W requirement of the motor oil comprises a blend of at least two fractions of the dewaxed, dearomatized, fractionated catalytically cracked stock, which has superior thermal stability as compared with solvent extracted neutral oils of comparable boiling range, and a unique ability to reduce the viscosity at 0°F. without decreasing the viscosity at 210°F. in the same ratio. The heavy component which fulfills the SAE—40 requirement is derived from a blend of the SEN 140 oil or SEN 100 oil and the SEN 750—800 oil. The properties of typical mineral oil stocks blended to formulate the motor oil of this invention are given in Table I.

The high boiling range of the light component of this lubricating oil formulation is uniquely obtained by combining at least two fractions of the dewaxed, dearomatized, catalytically cracked stock in certain definite ratios which apparently azeotrope, thereby retaining the high boiling range while reducing viscosity. It is highly important that a minimum amount of this light component boil below 725°F. and that the 210°F. viscosity remain as high as possible in order to minimize the quantity of the oil consumed by the engine. The trend in oil consumption by the engine as related to the amount of oil in the finished oil boiling below 725°F. is illustrated by the data given in Table II. These data show within limits of experimental error that oils containing substantially more than 12 volume percent of components boiling below 725°F. increase consumption above the tolerable limits.

In order for the light component of this base oil formulation to meet the consumption restriction and to fulfill the 5W requirement in the finished oil, the light component must have a minimum viscosity at 210°F. of 3.2 centistokes, a maximum viscosity at 0°F. of 5.9 poises, coupled with a restrictive boiling range of preferably 650° to 800°F. with no more than about 15 percent by volume of the oil boiling below 725°F. The light component of the base oil of this invention is therefore preferably a blend of from 5 to 18 percent by volume of an oil fraction of a dewaxed, dearomatized, catalytically cracked stock having a maximum of 80 percent of the oil by volume boiling below 725°F., a 210°F. viscosity in the range of from 2.8 to 2.9 centistokes, a 100°F. viscosity of from 11.5 to 11.9 centistokes and a 0°F. viscosity of from 2.2 to 2.9 poises, mixed with from 82 to 95 percent by volume of a dewaxed, dearomatized, catalytically cracked oil fraction having a maximum of 15 percent by volume of the oil boiling below 725°F., a 210°F. viscosity of from 3.8 to 4.0 centistokes, a 100°F. viscosity of from 18.7 to 19.0 centistokes, and a 0°F. viscosity of from 4.5 to 5.5 poises. Typical catalytically cracked oil fractions suitable for use in the light component of the base oil formulation are shown in Table I.

The ratio of these two oil fractions may vary to some extent with the type of additive employed in the finished oil, since in instances where the additive contains a diluent oil, the volatility of the base oil must be adjusted in accordance with the volatility of the diluent oil employed.

The heavy component of the base oil in this invention in order to fulfill the SAE 40 requirement of the finished oil must have a 300°F. viscosity of at least 2.5 centistokes in order to provide sufficient hydrodynamic film strength at high temperatures, a minimum 210°F. viscosity of 6.0 centistokes, a maximum 0°F. viscosity of 20.0 poises and with zero volume percent of the oil boiling below 725°F.

The heavy component having the above properties is obtainable by blending from 72 to 84 volume percent of a SEN 140 oil with from 16 to 28 volume percent of a SEN 750—800 oil, the properties of typical oils being given in Table I.

Although the requirements for a 5W—40 base oil can be essentially met with the oil blend comprising the light component of the present formulation, there is need for the heavy component to fulfill the 300°F. visco-

sity requirement essential for adequate film strength of the oil at high temperatures. Concomitantly, the heavy component should have properties which do not increase the 0°F. viscosity of the base oil formulation to above 5.7 poises. Such an oil is obtained with the blend of a SEN 750—800 oil with a SEN 140 oil or with a SEN 100 oil.

While a blend of the SEN 100 oil and the SEN 750—800 oil meet the viscometric requirements for the base oil at 0°F., minor problems associated with volatility occur with this particular formulation. However, the SEN 140 oil in the heavy component blend can be replaced with a SEN 100 oil provided the boiling range of the SEN 100 is restricted to within 720° to 835°F. It is again apparent that the minimum boiling point of such an oil is closely restricted to the region of 725°F. Viscometrically such an oil must have a viscosity of from 3.9 to 4.2 centistokes at 210°F. and a maximum viscosity of 6.15 poises at 0°F.

To attain a base oil that meets the viscosity and volatility criteria for the finished five-grade motor oil, the light and heavy components are blended in amounts ranging from 70 to 80 parts of the light component with from 20 to 30 parts of the heavy component on a volume basis, preferably with a volume ratio of 4:1. This blend of oil components in the proportions described form a base oil containing a maximum of 7 volume percent of the oil boiling below 725°F. with the following viscometric properties:

Minimum Viscosity at 300°F.	2.0 centistokes
Minimum Viscosity at 210°F.	4.0 centistokes
Maximum Viscosity at 0°F.	5.7 poises
Pour	0°F.
Flash	415—420°F.

The additives to be added to the base oil formulation in order to obtain a finished crankcase oil with the proper SAE specification are those that are available commercially, such as the A.P.I. Service S.E.-type additives. In the instant formulation two additives which are preferred to be mixed with the base oil are a viscosity index improver and a multifunctional additive which is also a detergent-dispersant-inhibitor-type additive. A representative additive of the former type is polymethylmethacrylate which typically may have a specific gravity of about 0.9, a viscosity at 210°F. of about 4200 SSU, and viscosity at 100°F. of about 63,000 SSU with a pour point of +25°F. A representative additive of the latter type typically has a specific gravity of 0.95, a viscosity at 210°F. of 156 SSU, and contains minor quantities of magnesium, nitrogen, phosphorus, sulfur and zinc. Chemically this additive contains zinc dialkyl dithiophosphate and calcium alkyl phenates as oxidation inhibitors, a succinimide as an ashless dispersant and magnesium sulfonate as a detergent.

A typical oil formulation falling within the limits specified hereinabove is illustrated by the following example:

EXAMPLE.

In a tank maintained at 140°F. and fitted with a continuous stirrer were blended 1335 gallons of a viscosity index improver consisting of polymethylmethacrylate 19110 gallons of a HV1—85 oil consisting of 12.9 volume percent of a fraction of a dewaxed dearomatized, catalytically cracked stock having a 210°F. viscosity of 2.85 centistokes and a 100°F. viscosity of 11.5 centistokes, and 87.1 volume percent of a fraction having a 210°F. viscosity of 3.89 centistokes and a 100°F. viscosity of 19.01 centistokes. In a separate tank at 140°F. were mixed, with continuous stirring, 3450 gallons of SEN 140 oil, 1320 gallons of SEN 750 oil, 1335 gallons of the above viscosity index improver and 3450 gallons of a detergent-dispersant-inhibitor additive comprising a mixture of a zinc dialkyl dithiophosphate, a calcium alkyl phenate, magnesium sulfonate and a succinimide. To this mixture were added the above blend of HV1—85 oil and viscosity index improver. The final oil blend fulfilled the necessary requirements for a five-grade SAE 5W—40 motor oil.

TABLE I

Properties of Typical Oil Components in Base Oil formulation

	Dewaxed	Cat. Cracked Stocks	SEN 100	SEN 140	SEN 750–800
Viscosity 300°F., Cs	<1.5	2.0	–	2.3	5.1
Viscosity 210°F., Cs	2.85	3.89	4.15	5.0	14.23
Viscosity 100°F., Cs	11.5	19.01	21.75	30.37	160.0
Viscosity 0°F., poises	2.8	5.5	6.15	11.1	>100.0
Distillation °F., 760 mm*					
IBP	622	690	700	719	722
2	647	–	722	735	865
5	652	714	730	748	892
10	662	721	733	753	904
20	670	731	740	762	922
50	693	750	753	785	964
90	732	790	789	835	1035
95	747	812	808	860	1032
E.P.	770	816	818	880	–

* ASTM D–1160

TABLE II

Effect of <725°F. Component on Oil Consumption of Finished Oil

Oil Type	10W–40	10W	5W–40	5W–40	5W–40	5W–40
<725°F. Component, Vol. %*	0	17	34.5	20	12	9
Oil Consumption, Oz/Hr.	2.28	4.0	4.43	3.42	2.0	2.94

* ASTM D–1160

WHAT WE CLAIM IS:—

1. A blended base oil composition for use in a five-grade SAE 5W—40 motor oil consisting of a blend of the following mineral oil components:

Component (A) which consists of a mixture of

(1) from 72 to 84 parts by volume of a solvent extracted neutral oil of about 140 SSU viscosiy at 100°F., or a solvent extracted neutral oil of 100 SSU viscosity at 100°F., having a boiling point in the range of 720° to 835°F., a viscosity of from 3.9 to 4.2 centistokes at 210°F. and a maximum viscosity of 6.15 poises at 0°F., and

(2) from 16 to 28 parts by volume of a solvent extracted neutral oil of 750 to 800 SSU viscosity, at 100°F.,

said component (A) having a minimum viscosity at 300°F. of 2.5 centistokes, a minimum viscosity at 210°F. of 6.0 centistokes, a maximum viscosity at 0°F. of 20.0 poises, with zero percent of the oil boiling below 725°F; and

Component (B) which consists of a blend of at least two fractions of dewaxed oils obtained from substantially aromatic-free catalytically cracked stock, said blend having a minimum viscosity at 210°F. of 3.2 centistokes, a maximum viscosity at 0°F. of 5.9 poises and a maximum of 15 percent by volume of the dewaxed oils boiling below 725°F.;

and wherein component (B) comprises from 70 to 80 percent by volume of the total base oil composition.

2. The blended base oil composition of claim 1 wherein component (B) consists of a blend of

(1) from 5 to 18 parts by volume of an oil fraction of a dewaxed, catalytically cracked stock having a viscosity at 210°F. of from 2.8 to 2.9 centistokes, a maximum viscosity at 0°F. of 2.9 poises, and a maximum of 80 percent by volume of said oil fraction boiling below 725°F; and

(2) from 82 to 95 parts by volume of an oil fraction from said catalytically cracked

stock having a viscosity at 210°F. of from 3.8 to 4.0 centistokes, a maximum viscosity at 0°F. of 5.5 poises and a maximum of 15 percent by volume of said oil fraction boiling below 725°F.

3. The blended base oil composition of claim 2 wherein the volume ratio of component (B) to component (A) is 4 to 1.

4. A five-grade SAE 5W—40 motor oil with excellent consumption properties and thermal and wear stability having a measured viscosity at 0°F. not to exceed 12.0 poises, a minimum viscosity at 210°F. of 14.7 centistokes, a minimum viscosity at 300°F. of 6.5 centistokes, and wherein no more than 12 percent by volume of the oil boils below 725°F., comprising a multifunctional detergent-dispersant-inhibitor additive, a viscosity index improver and a base oil composition as claimed in any of claims 1 to 3.

5. The composition in claim 4 wherein said viscosity index improver is polymethylmethacrylate and said multifunctional detergent additive comprises a mixture of zinc dialkyl dithiophosphate, a calcium alkyl phenate, a succinimide, and magnesium sulfonate.

6. A blended oil base composition as claimed in claim 1 substantially as herein described with reference to the Example.

7. A five-grade SAE 5W—40 motor oil as claimed in claim 4 substantially as herein described with reference to the Example.

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